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Proposed Best Demonstrated Available Technology (BDAT) Background Document for Oxygenated Hydrocarbon and Heterocyclic U and P Wastes. Volume 8

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This background document provides the Agency's rationale and technical support for selecting constituents being proposed for regulation and for developing treatment standards for these wastes. This document also provides waste characterization data that serve as a basis for determining whether a variance from treatment standards may be warranted for a particular oxygenated hydrocarbon and heterocyclic waste that is more difficult to treat than the wastes that were tested and from which treatment performance data were used to develop the treatment standards for the wastes included in this background document.

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PROPOSED

BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

BACKGROUND DOCUMENT

FOR

OXYGENATED HYDROCARBON AND

HETEROCYCLIC U AND P WASTES

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November 1989

Note: This proposed Background Document has been prepared in support of the Agency's proposed rulemaking for the land disposal restrictions program. The Agency solicits comments on the proposed rule and on this proposed Background Document. This document will be issued in final form, appropriately revised in response to comments, at the time of promulgation of the final rule.

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1.0 INTRODUCTION

1.1 Regulatory Background

Section 3004(m) of the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA) on November 8, 1984, requires the U.S. Environmental Protection Agency (EPA or the Agency) to promulgate treatment standards for certain hazardous wastes based on the Best Demonstrated Available Technology (BDAT) for those wastes. More than 500 of these hazardous wastes were listed as of December 1988 (see Title 40, Code of Federal Regulations, Part 261 (40 CFR Part 261)). The Agency divided the listed hazardous wastes into five groups. The wastes in each group are examined to determine whether further land disposal is protective of human health and the environment (see 40 CFR Part 268). The five groups and their respective dates of promulgation of treatment standards are:

o	Solvent and dioxin wastes	November 7, 1986
o	"California List" wastes	July 8, 1987
o	"First Third" wastes	August 8, 1988
o	"Second Third" wastes	June 8, 1989
o	"Third Third" wastes	on or before May 8, 1990

Several wastes included in this schedule were regulated ahead of schedule, and several wastes in the "First Third" or "Second Third" group of wastes were deferred to the "Third Third" group of wastes. Treatment standards for the Third Third wastes will become effective no later than May 8, 1990. On and after this date, wastes regulated in the "Third Third" rulemaking will have to

comply with applicable treatment standards prior to "land disposal" as defined in 40 CFR Part 268.

Treatment standards are specified for both nonwastewater and wastewater forms of each listed hazardous waste. In general, numerical treatment standards were developed for wastes that are amenable to quantification in hazardous waste matrices and treatment standards specifying methods of treatment were developed for wastes that are not amenable to quantification in hazardous waste matrices using current analytical methods. These standards are applicable to the wastes as listed as well as to any wastes generated by the management or treatment of the listed waste. For the purpose of determining the applicability of the treatment standards, wastewaters are defined as wastes containing less than 1% (weight basis) total suspended solids[1] and less than 1% (weight basis) total organic carbon (TOC). Wastes not meeting the wastewater definition must comply with treatment standards for nonwastewaters.

The 34 oxygenated hydrocarbon and heterocyclic U and P wastes that are the subject of this document are listed in Table 1-1 by waste code. Table 1-1 also lists the constituents for which the wastes were listed. These

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[1]The term "total suspended solids" (TSS) clarifies EPA's previously used terminology of "total solids" and "filterable solids." Specifically, total suspended solids are measured by Method 209c (Total Suspended Solids Dried at 103 to 105°C) in Standard Methods for the Examination of Water and Wastewater (Reference 1).

wastes have been combined into one waste treatability group, as discussed in Section 2.3. This background document provides the Agency's rationale and technical support for selecting constituents being proposed for regulation and for developing treatment standards for these wastes. This document also provides waste characterization data that serve as a basis for determining whether a variance from treatment standards may be warranted for a particular oxygenated hydrocarbon and heterocyclic waste that is more difficult to treat than the wastes that were tested and from which treatment performance data were used to develop the treatment standards for the wastes included in this background document.

U and P wastes consist of commercial chemical products or manufacturing intermediates from a nonspecific source containing any of the chemicals listed in 40 CFR 261.33(e) or (f) and in which the listed chemical is the sole active ingredient. Commercial chemical products or manufacturing intermediates include all commercially pure grades of the listed chemical, all technical grades, and all formulated products in which the listed chemical is the sole active ingredient (but not products containing mixtures of listed commercial chemicals). In addition, an off-specification product that, if it met specification, would have the generic name included in either 261.33(e) or (f), is a U or P waste. Any residue that is a listed chemical remaining in a container or inner liner removed from a container that will not be recycled, reclaimed, or reused; or any residue or contaminated soil, water, or debris from a spill of such a chemical, is also a U or P waste. However, these

wastes do not include manufacturing process wastes. A waste occurs when a product is:

- o Discarded or intended to be discarded;
- o Mixed with another material and applied to the land for dust suppression or road treatment;
- o Applied to land in lieu of its original intended use;
- o Distributed or burned as a fuel or fuel additive;

U wastes are identified as toxic; P wastes are identified as acutely hazardous. Whether a waste is acutely hazardous or toxic generally has no bearing on its treatability.

1.2 Document Summary

This document provides the Agency's rationale and technical support for developing treatment standards for the 34 oxygenated hydrocarbon and heterocyclic U and P wastes listed in Table 1-1. Section 2.0 of this background document presents the following waste-specific information: the approximate number and geographic distribution of facilities that may be affected by the land disposal restrictions for the oxygenated hydrocarbon and heterocyclic wastes listed in Table 1-1; the processes generating these wastes; and available waste characterization data. The Agency estimates that there are approximately 275 facilities that may be affected by this rule. The four-digit Standard Industrial Classification (SIC) codes associated with the organic chemicals industry is 2869 (Industrial Organic Chemicals, Not

Elsewhere Classified). Section 2.0 also includes EPA's rationale for combining these waste codes into one treatability group.

EPA's rationale for identifying BDAT for the wastes included in this document is presented in Section 3.0. Specifically, BDAT has been identified to be incineration or fuel substitution for all nonwastewater forms of these wastes and for wastewater forms of these wastes that are amenable to quantification using current analytical methods. BDAT for wastewater forms of these wastes that cannot be quantified using current analytical methods is wet air oxidation followed by carbon adsorption, chemical oxidation followed by carbon adsorption, biological treatment followed by carbon adsorption, and incineration.

Alternate concentration-based treatment standards for all U and P wastewaters have also been developed based on additional wastewater treatment data from several technologies. These data and the corresponding treatment technologies are discussed in Reference 3 and are included in Sections 111.A.2.a.(3.) and 111.A.1.h.(b.) of the preamble.

Section 4.0 contains the treatment performance data that the Agency used to determine BDAT and the proposed treatment standards for the wastes included in this document. The Agency has treatment performance data for nonwastewaters and wastewaters from 14 incineration tests performed by EPA for the BDAT program.

Recently, additional wastewater treatment data, primarily from EPA's Office of Water, have been analyzed for the development of concentration-based treatment standards for many of the U and P wastes. These data include treatment performance data for wastewaters that are not specifically listed as U or P wastewaters, but do contain many of the corresponding U or P waste constituents. While these data were not available in time for incorporation into the preamble discussion or into this background document for specific wastes or waste treatability groups, these data are being placed in the administrative record for this rulemaking. Furthermore, the Agency has decided to propose alternative concentration-based treatment standards, based on the aforementioned data, for all U and P wastewaters for which standards based on incinerator scrubber waters have been proposed. Further information on these alternative standards can be found in Sections III.A.2.a.(3.) and III.A.1.h.(b.) of the preamble for the proposed rule and in the document Best Demonstrated Available Technology (BDAT) Background Document for Wastewaters Containing BDAT List Constituents (Reference 3).

The Agency has also conducted wastewater treatment tests for selected U and P chemicals using wet air oxidation, powdered activated carbon treatment (PACT), and carbon adsorption. Since much of the currently available wastewater treatment data is from the treatment of relatively low concentrations of U and P waste constituents in industrial wastewaters, these tests have been designed to examine the applicability of treatment technologies to wastewaters containing relatively high concentrations of U and P constituents. The data developed in these studies are included in the

administrative record for inspection and comment. Further information on the availability of the wastewater treatment test data can be found in Section III.A.1.h.(6.) of the preamble for the proposed rule.

EPA's rationale for selecting constituents for proposed regulation by means of numerical treatment standards is presented in Section 5.0. Due to the lack of characterization data for U and P wastewaters and nonwastewaters, only the constituent for which the waste was listed was considered for regulation. However, many of these U and P waste constituents cannot be quantified in hazardous waste matrices using current analytical methods. In these cases, the Agency is specifying a method of treatment as the BDAT treatment standard since, without analytical methods, establishing numerical treatment standards for the constituents of concern would not be appropriate.

Section 6.0 includes the determination of proposed treatment standards for the oxygenated hydrocarbon and heterocyclic wastes listed in Table 1-1. Tables 1-2 through 1-5 (at the end of this section) present the proposed treatment standards for these wastes. The units used for total constituent concentration of organic constituents are mg/kg (parts per million on a weight-by-weight basis) for the nonwastewater forms of these wastes, and mg/l (parts per million on a weight-by-volume basis) for the wastewater forms of these wastes. Proposed BDAT treatment standards for U and P wastes included in this document were determined based on treatment performance data from the 14 incineration tests discussed in Section 4.0. Alternative treatment standards for U and P wastewaters were determined based on treatment

performance data from several sources of wastewater treatment data, as discussed in the Wastewater Background Document (Reference 3).

Section 7.0 acknowledges the persons involved in developing the regulations for these wastes. Section 8.0 lists the references cited in this document. Appendix A presents the chemical structures of all of the constituents in the waste codes included in this document. Appendix B summarizes the plant codes and plant names referenced in this document. Appendix C presents relevant QA/QC information corresponding to the treatment performance data presented in Section 4.0. Appendix D includes the variability factor calculations discussed in Section 6.1 of this document.

Table 1-1

WASTES INCLUDED IN THIS BACKGROUND DOCUMENT

ANALYZABLE CONSTITUENTS:

Waste Code	Constituent
P003[a]	Acrolein
U002	Acetone
U004	Acetophenone
U031	n-Butanol
U057	Cyclohexanone
U108	1,4-Dioxane
U112	Ethyl acetate
U117	Ethyl ether
U118	Ethyl methacrylate
U140	Isobutyl alcohol
U154[a]	Methanol
U159	Methyl ethyl ketone
U161	Methyl isobutyl ketone
U162	Methyl methacrylate
U166	1,4-Naphthoquinone
U197	p-Benzoquinone

NONANALYZABLE CONSTITUENTS:

Waste Code	Constituent
P001	Warfarin (>3%)
P005	Allyl alcohol
P088	Endothall
P102	Propargyl alcohol
U001	Acetaldehyde
U008	Acrylic acid
U053	Crotonaldehyde
U085	1, 2:3, 4-Diepoxybutane
U113	Ethyl acrylate
U122	Formaldehyde
U123	Formic aid
U124	Furan
U125	Furfural
U126	Glycidylaldehyde
U147	Maleic anhydride
U182	Paraldehyde
U213	Tetrahydrofuran
U248	Warfarin (<3%)

[a]Although a method to analyze for the constituent in this waste exists, a method of treatment is being proposed as the BDAT treatment standard for the nonwastewater form of this waste. This is discussed in more detail in Section 6.1 of this document.

Table 1-2

PROPOSED BDAT TREATMENT STANDARDS FOR WASTES THAT ARE AMENABLE TO QUANTIFICATION IN HAZARDOUS WASTE MATRICES USING CURRENT ANALYTICAL METHODS

NONWASTEWATER

Maximum for Any Single Grab Sample	
Waste Code/Name	Total Concentration (mg/kg)
U002 Acetone	0.14
U004 Acetophenone	9.6
U031 n-Butanol	2.6
U057 Cyclohexanone	1.9
U108 1,4-Dioxane	280
U112 Ethyl acetate	5.6
U117 Ethyl ether	140
U118 Ethyl methacrylate	160
U140 Isobutyl alcohol	170
U159 Methyl ethyl ketone	200
U161 Methyl isobutyl ketone	33
U162 Methyl methacrylate	160
U166 1,4-Naphthoquinone	1.9
U197 p-Benzoquinone	180

Table 1-5

PROPOSED BDAT TREATMENT STANDARDS FOR WASTES THAT ARE NOT AMENABLE TO QUANTIFICATION IN HAZARDOUS WASTE MATRICES USING CURRENT ANALYTICAL METHODS

WASTEWATER

Waste Code	Waste Name	Method of Treatment
P001	Warfarin (>3%)	Wet air oxidation followed by carbon adsorption, chemical oxidation followed by carbon adsorption, biological treatment followed by carbon adsorption, and incineration.
P005	Allyl alcohol	
P088	Endothall	
P102	Propargyl alcohol	
U001	Acetaldehyde	
U008	Acrylic acid	
U053	Crotonaldehyde	
U085	1,2:3,4-Diepoxybutane	
U113	Ethyl acrylate	
U122	Formaldehyde	
U123	Formic acid	
U124	Furan	
U125	Furfural	
U126	Glycidylaldehyde	
U147	Maleic anhydride	
U154	Methanol	
U182	Paraldehyde	
U213	Tetrahydrofuran	
U248	Warfarin (<3%)	

Table 1-3

PROPOSED BDAT TREATMENT STANDARDS FOR WASTES THAT ARE NOT AMENABLE TO QUANTIFICATION IN HAZARDOUS WASTE MATRICES USING CURRENT ANALYTICAL METHODS

NONWASTEWATER

Waste Code	Waste Name	Method of Treatment
P001	Warfarin (>3%)	Incineration or fuel substitution
P003[a]	Acrolein	
P005	Allyl alcohol	
P088	Endothall	
P102	Propargyl alcohol	
U001	Acetaldehyde	
U008	Acrylic acid	
U053	Crotonaldehyde	
U085	1,2:3,4-Diepoxybutane	
U113	Ethyl acrylate	
U122	Formaldehyde	
U123	Formic acid	
U124	Furan	
U125	Furfural	
U126	Glycidylaldehyde	
U147	Maleic anhydride	
U154[a]	Methanol	
U182	Paraldehyde	
U213	Tetrahydrofuran	
U248	Warfarin (<3%)	

[a]Although a method to analyze for the constituent in this waste exists, a method of treatment is being proposed as the BDAT treatment standard for the nonwastewater form of this waste. This is discussed in more detail in Section 6.1 of this document.

Table 1-4

PROPOSED BDAT TREATMENT STANDARDS FOR WASTES THAT ARE AMENABLE TO QUANTIFICATION IN HAZARDOUS WASTE MATRICES USING CURRENT ANALYTICAL METHODS[a]

WASTEWATER

Waste Code/Name	Maximum for Any Single Grab Sample: Total Concentration (mg/l)
P003 Acrolein	3.6
U002 Acetone	0.25
U004 Acetophenone	0.17
U031 n-Butanol	0.56
U057 Cyclohexanone	1.4
U108 1,4-Dioxane	0.80
U112 Ethyl acetate	0.0052
U117 Ethyl ether	0.28
U118 Ethyl methacrylate	0.47
U140 Isobutyl alcohol	1.4
U159 Methyl ethyl ketone	0.14
U161 Methyl isobutyl ketone	0.028
U162 Methyl methacrylate	0.47
U166 1,4-Naphthoquinone	0.073
U197 p-Benzoquinone	13

[a]Alternative treatment standards for these U and P wastewaters are also proposed and are presented in section III.A.7. of the preamble as treatment standards for the corresponding chemical in wastewater forms of multi-source leachate. Additional information concerning these alternative treatment standards are included in section III.A.1.h.(6.)(b.).

2.0 INDUSTRY AFFECTED AND WASTE CHARACTERIZATION

This section describes the industries affected by the land disposal restrictions for the wastes listed in Table 1-1, the processes generating the wastes, the available characterization data, and the determination of waste treatability groups.

2.1 Industry Affected

Industries that generate these wastes include the organic chemical, agricultural chemical, plastic and resin, cosmetic and fragrance, paint, pharmaceutical, and leather and tanning industries. Table 2-1 identifies the industrial uses of the commercial chemical products containing the constituents of concern listed in Table 1-1. The Agency estimates that there are approximately 275 facilities that may generate these wastes of interest. Table 2-2 summarizes the total number of facilities that may generate each waste code. The number of facilities that may generate the waste codes are also listed by state and EPA region in Table 2-3.

2.2 Waste Characterization

P wastes include discarded commercial chemical products, manufacturing chemical intermediates, off-specification commercial chemical products, container residues, and spill residues, including contaminated water, soil, or debris, that are identified as acutely hazardous wastes. U

wastes include discarded commercial chemical products, manufacturing chemical intermediates, off-specification commercial chemical products, and spill residues, including contaminated water, soil, or debris, that are identified as toxic wastes. Due to the diversity of methods of waste generation, the composition of these wastes varies greatly. The constituents of concern may be present at concentrations varying from several parts per million to nearly 100% in virtually pure product. Waste characterization data are not available for any of the waste codes included in the this document. Section 1.0 discusses the definition of U and P wastes in greater detail.

2.3 Determination of Waste Treatability Groups

The Agency based its determination of waste treatability group(s) on similarities in elemental composition and functional groups present within the structure of the waste constituents of concern.

The primary constituents of the 34 U and P wastes discussed in this document are oxygenated organic compounds. These compounds contain at least one oxygen atom integrated into the chemical structure by a single or double bond to a carbon. As a result, this group includes functional groups such as ketones, aldehydes, and alcohols.

All 34 of these wastes have been judged to be structurally similar, based on the presence of oxygen functional groups. Also, these wastes are expected to be treated to similar concentrations by the technologies that are

determined to be BDAT (discussed in Section 3.0 of this document). Accordingly, all 34 oxygenated hydrocarbon and heterocyclic wastes were combined into one treatability group.

TABLE 2-1

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U001	Acetaldehyde	Food Processing	Synthetic flavor ingredient
		Plastics and Resins Manufacturing	Manufacture of resins and plastics
		Dyes and Pigments Manufacturing	Manufacture of dyes
		Cosmetics and Fragrances	Manufacture of perfumes
		Organic Chemical Manufacturing	Chemical intermediate for pyridine, pyridine bases, pentaerythritol, 1,3-butylene glycol, chloral, glyoxal, crotonaldehyde, acetaldehyde 1,1-dimethylhydrazone, acetaldehyde cyanohydrin, acetaldehyde oxime, paraldehyde, metaldehyde, halogenated derivatives, acetaldol, sodium sulphite addition product, acetic anhydride, ethylidene diacetate, alkyl amine, ethyl acetate, isobutyl acetate, lactic acid, acetic acid, peracetic acid
		Agricultural Chemical Manufacturing	Chemical intermediate for pesticides
		Film	Chemical intermediate for photographic formulations
			Alcohol denaturant
		Organic Chemical Manufacturing	Monomer for polyacetaldehyde and comonomer for polymers
U002	Acetone	Fiber Manufacturing	Spinning solvent for cellulose acetate
		Electronic Components Manufacturing	Cleaning and drying electronic parts
		Paint Manufacturing	Solvent for paints, varnishes, lacquers
		Plastics and Resins Manufacturing	Solvent for resins and plastics
		Pharmaceutical Manufacturing	Solvent in the manufacture of pharmaceuticals
		Explosives	Manufacture of smokeless powder
		Organic Chemical Manufacturing	Solvent for fats, oils waxes Manufacture of mesityl oxide, acetic acid, diacetone, alcohol, chloroform, iodoform, bromoform, acetic anhydride Chemical intermediate for methacrylates, methyl isobutyl ketone, methyl isobutyl carbinol, bisphenol A, isophorone

[a] Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U002 (Continued)		Printing	Solvent for printing inks
U004	Acetophenone	Dyes and Pigments Manufacturing	Solvent for dyes
		Plastics and Resins Manufacturing	Specialty solvent for plastics and resins
		Organic Chemical Manufacturing	Chemical intermediate for the odorant, ethyl methyl phenylglycidate, the riot control agent, 2-chloroacetophenone, 2-bromoacetophenone, for dyes, 3-nitroacetophenone
		Food Processing	Flavoring agent in non-alcoholic beverages, ice cream, candy, baked goods, gelatins, and puddings
		Cosmetics and Fragrances	Fragrance ingredient in soaps, detergents, creams, lotions, and perfumes
			Flavoring in tobacco
U008	Acrylic acid	Organic Chemical Manufacturing	Chemical intermediate for ethyl acrylate, n-butyl acrylate, methyl acrylate, 2-ethylhexyl acrylate, acrylate hydoxyethyl Monomer for polyacrylic acid and salts Comonomer with acrylamide for polymers used as flocculants Surface coatings
		Textiles	Textile applications
		Cleaning Products	Manufacture of polishes
		Leather and Tanning	Manufacture of leather
U031	n-Butyl alcohol	Plastics and Resins Manufacturing	Production of water soluble resins and salts
		Pharmaceutical Manufacturing	Manufacture of pharmaceuticals
		Veterinary Medicine	Bactericide
		Furniture Manufacturing	Solvent for surface coatings
		Organic Chemical Manufacturing	Chemical intermediate for ethylene glycol, monobutyl ethers, glycol ethers, plasticizers,

a Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U031 (Continued)			n-butyl acetate, n-butyl acrylate, butylamines, 2,4-D esters
			Dehydrating agent
			Solvent for vegetable oils and alkaloids
U053	Crotonaldehyde	Organic Chemical Manufacturing	Chemical intermediate for 2-ethylhexyl alcohol
		Plastics and Resins Manufacturing	Solvent for polyvinyl chloride
		Tire	Preparation of rubber accelerators
		Petroleum Refining	Purification of lubricating oils
		Agricultural Chemical Manufacturing	Manufacture of insecticides
		Military	Manufacture of tear gas
		Organic Chemical Manufacturing	Organic synthesis
		Leather and Tanning	Leather tanning
U057	Cyclohexanone	Organic Chemical Manufacturing	Alcohol denaturant
			Chemical intermediate in synthesis of caprolactam adipic acid, and methacrylate ester polymers
			Solvent for waxes and fats
		Paint Manufacturing	Solvent for lacquers, wood stains, paint, and varnish removers
		Plastics and Resins Manufacturing	Solvent for polyvinyl chloride and its copolymers
			Solvent for natural and synthetic resins
		Leather and Tanning	Spot remover and degreaser for leather
U085	1,2:3,4-Diepoxybutane	Commercial Testing Laboratories	Research chemical
U108	1,4-Dioxane	Cosmetics and Fragrances	Manufacture of cosmetic products
		Paint Manufacturing	Manufacture of lacquers, paints, varnishes, paint and varnish removers
		Paper Processing	Solvent in pulping of wood
		Dyes and Pigments Manufacturing	Wetting and dispersing agent in textile processing, dye-baths, stain and printing compositions

a Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U108 (Continued)			
		Cleaning Products	Manufacture of cleaning and detergent preparations, adhesives, fumigants, emulsions, and polishing compositions
		Organic Chemical Manufacturing	Solvent for fats, oils, waxes
		Plastics and Resins Manufacturing	Solvent for natural and synthetic resins
U112	Ethyl acetate	Organic Chemical Manufacturing	Organic synthesis
		Medicine	Carminative, antispasmodic, and counterirritant
			Component of base sheet (cellophane)
		Food Processing	Diluent in inks for marking fruits and vegetables, synthetic flavoring
		Plastics and Resins Manufacturing	Solvent for plastics
		Printing	Solvent for inks
		Paint Manufacturing	Solvent for varnishes, lacquers
		Explosives	Manufacture of smokeless powder
		Film	Manufacture of photographic films and plates
		Leather and Tanning	Manufacture of artificial leather
		Cosmetics and Fragrances	Manufacture of perfumes
U113	Ethyl acrylate	Paint Manufacturing	Emulsion polymers for trade sale paints
		Textiles	Textile coating and printing
		Paper Coating	Paper coatings
		Cleaning Products	Floor finishes
		Adhesives and Sealants	Emulsion polymers for adhesives and sealants
		Leather and Tanning	Leather finishes
		Food Processing	Synthetic flavorings

a Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U113 (Continued)			
		Cosmetics and Fragrances	Manufacture of fragrances
U117	Diethyl ether	Organic Chemical Manufacturing	Solvent for waxes, fats, and oils Reagent for organic synthesis Chemical intermediate for monoethanolamine, ethylene
		Cosmetics and Fragrances	Solvent for perfumes
		Explosives	Manufacture of gun powder
		Automotive	Primer for gasoline engines
		Commercial Testing Laboratories	Extractant of hormones from plant and animal tissues
		Veterinary Medicine	Inhalation anesthetic, antispasmodic, rubefacient
U118	Methacrylic acid, ethyl ester	Plastics and Resins Manufacturing	Comonomer in acrylic polymers for surface coating resins
		Cleaning Products	Acrylic emulsion polymers for polishes
		Pharmaceutical Manufacturing	Comonomer in denture base material
U122	Formaldehyde	Plastics and Resins Manufacturing	Chemical intermediate for phenolic, polyacetal and melamine resins Chemical intermediate for resorcinol-formaldehyde and aniline-formaldehyde resins
		Organic Chemical Manufacturing	Chemical intermediate for acetylenic chemicals, (1,4-butanediol), polyols (pentaerythritol), hexamethylenetetramine, methylene dianiline, pyridine chemicals, nitroparaffin derivatives
		Tire	Chemical intermediate for rubber processing chemicals
		Medicine	Disinfectant Embalming agent
		Dyes and Pigments Manufacturing	Component of dyes as starch preservative
		Leather and Tanning	Chemical intermediate for synthetic tanning agent
		Explosives	Chemical intermediate for explosives
		Agriculture	Soil sterilant in mushroom houses before planting

a Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U123	Formic acid	Agricultural Chemical Manufacturing	Manufacture of fumigants, insecticides
		Paint Manufacturing	Manufacture of commercial paint strippers, lacquers
		Textiles	Dyeing and finishing of textiles
		Organic Chemical Manufacturing	Preparation of organic esters
			Manufacture of refrigerants
		Cosmetics and Fragrances	Solvent for perfumes
		Medicine	Antiseptic
			Silvering glass
		Fiber Manufacturing	Cellulose formate
			Ore floatation
		Plastics and Resins Manufacturing	Manufacture of vinyl resin plasticizers
		Leather and Tanning	Leather tanning
U124	Furan	Organic Chemical Manufacturing	Chemical intermediate for tetrahydrofuran Organic synthesis for pyrrole, thiophene
U125	Furfural	Organic Chemical Manufacturing	Solvent in extraction of butadiene from C4 streams
		Petroleum Refining	Refining of lubricating oils
		Adhesives and Sealants	Constituent of rubber cement
		Food Processing	Synthetic flavoring ingredient
		Plastics and Resins Manufacturing	Solvent for synthetic and natural resins
		Medicine	Screening test for urine
		Paint Manufacturing	Manufacture of varnishes
		Agricultural Chemical Manufacturing	Insecticide, fungicide, germicide

a Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U125 (Continued)		Automotive	Wetting agent in the manufacture of abrasive wheels and brake linings
U126	Glycidylaldehyde	Commercial Testing Laboratories	Research chemical
		Wool Weaving and Finishing	Cross-linking agent for finishing of wool
		Leather and Tanning	Oil tanning and fat-liquoring of leather
		Medicine	Oil tanning and fat-liquoring of surgical sutures
			Protein insolubilization
			Chemical intermediate in glycerol manufacture
U140	Isobutyl alcohol	Food Processing	Manufacture of food additives
		Plastics and Resins Manufacturing	Solvent for surface coatings and adhesives
			Chemical intermediate for isobutyl esters used as plasticizers
		Cosmetics and Fragrances	Manufacture of perfumes
		Pharmaceutical Manufacturing	Processing solvent for pharmaceuticals
		Agricultural Chemical Manufacturing	Processing solvent for pesticides
		Organic Chemical Manufacturing	Chemical intermediate for isobutylamines, zinc diisobutyldithiophosphate, isobutyl acetate, acrylate and methacrylate esters
			Diluent-reagent in the alkylation of amino resins
		Petroleum Refining	Cosolvent in tertiary oil recovery
			Chemical intermediate for isobutyl esters used as plasticizers
U147	Maleic anhydride	Organic Chemical Manufacturing	Diene syntheses, co-polymerization reactions
			Chemical intermediate for fumaric acid, malic acid
			Chemical intermediate for surfactants, chlorendic anhydride and acid, rosin adducts
		Plastics and Resins Manufacturing	Manufacture of alkyd-type resins, reactive plasticizers
			Comonomer for unsaturated polyester resins
		Dyes and Pigments Manufacturing	Manufacture of dye intermediates

a Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U147 (Continued)		Pharmaceutical Manufacturing	Manufacture of pharmaceuticals
		Agricultural Chemical Manufacturing	Manufacture of agricultural chemicals
		Petroleum Refining	Chemical intermediate for lube oil dispersants and corrosion inhibitors
U154	Methyl alcohol		Kill animal pathogenic bacteria and maggots on household contents, mortuary instruments, human bedding and clothing, tissues, human stools, and cadavers
		Agricultural	Treatment against onion smut, dutch elm disease, and wood root
		Petroleum Refining	Kill slime forming bacteria in oil recovery injection water and packer fluid
		Printing	Duplicating fluid
			Removal of 2,4-dinitrotoluene from spent carbons
			Removal of toxic organic pollutants from soil
U159	Methyl ethyl ketone	Paint Manufacturing	Manufacture of paint removers
		Cement	Manufacture of cements
		Adhesives and Sealants	Manufacture of adhesives Solvent for adhesives
		Cleaning Products	Cleaning fluids
		Organic Chemical Manufacturing	Organic synthesis Oxidation promoter in manufacture of terephthalic acid from p-xylene
		Building Products	Solvent for coatings
		Magnetic Tape	Solvent for magnetic tape
		Printing	Solvent for printing inks
		Agricultural Chemical Manufacturing	Solvent for cosolvent in pesticide formulations

a Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U159 (Continued)		Medicine	Sterilizer for baterial spores on surgical instruments, hypodermic needles/syringes, and dental instruments
U161	Methyl isobutyl ketone		Denaturant for rubbing alcohol
		Paint Manufacturing	Solvent for paints, varnishes, cellulose lacquer
			Manufacture of methyl amyl alcohol
		Organic Chemical Manufacturing	Organic synthesis, extraction processes
		Pharmaceutical Manufacturing	Manufacture of antibiotics
		Dry Cleaning	Manufacture of dry cleaning preparations
		Food Processing	Manufacture of synthetic flavoring substances
U162	Methyl methacrylate	Organic Chemical Manufacturing	Monomer for polymethyl methacrylate, comonomer for copolymers Chemical intermediate for higher methacrylate esters
U166	1,4-Naphthoquinone	Tire	Polymerization regulator for rubber
		Plastics and Resins Manufacturing	Polymerization regulator for polyester resins
		Dyes and Pigments Manufacturing	Synthesis of dyes
		Pharmaceutical Manufacturing	Synthesis of pharmaceuticals
		Agricultural Chemical Manufacturing	Algicide
U182	Paraldehyde	Organic Chemical Manufacturing	Substitute for acetaldehyde Solvent for fats, oils, waxes
		Dyes and Pigments Manufacturing	Manufacture of dyestuff intermediates
		Plastics and Resins Manufacturing	Solvent for gums, resins
		Leather and Tanning	Manufacture of leather
		Fiber Manufacturing	Mixtures for cellulose derivatives
U197	1,4-Benzoquinone	Agricultural Chemical Manufacturing	Manufacture of fungicides
		Organic Chemical Manufacturing	Analytical reagent, oxidizing agent Determination of amino acids by the formation of red charge-transfer complexes

[a] Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
U197 (Continued)		Film	Photography
		Leather and Tanning	Tanning hides
		Cosmetics and Fragrances	Transform nitrogen containing-compounds into colored substances
U213	Tetrahydrofuran	Food Processing	Indirect food additive for food contact surface of articles intended for use in food processing
		Plastics and Resins Manufacturing	Solvent for resins and plastics
		Organic Chemical Manufacturing	Chemical intermediate for polytetramethylene glycol, tetrahydrothiophene
		Magnetic Tape	Solvent for top coating solutions, protective coatings, coating magnetic tapes
		Cleaning Products	Solvent for cleaning
			Agent in liquid membrane electrode manufacturing
			Polymerization solvent
		Printing	Solvent for print inks
			Solvent for production of tetraethyl and tetramethyl lead
U248	Warfarin	Agricultural Chemical Manufacturing	Rodenticide for norway rats and house mice
		Medicine	Anticoagulant therapy
P001	Warfarin	Agricultural Chemical Manufacturing	Rodenticide for norway rats and house mice
		Medicine	Anticoagulant therapy
P003	Acrolein	Agricultural Chemical Manufacturing	Pesticide
		Organic Chemical Manufacturing	Chemical intermediate in synthesis of glycerin, acrylic acid and esters

a Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

TABLE 2-1 (Continued)

INDUSTRIAL USE OF THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

WASTECODE	NAME	INDUSTRY	USE[a]
P003 (Continued)		Pharmaceutical Manufacturing	Chemical intermediate for pharmaceuticals
		Plastics and Resins Manufacturing	Chemical intermediate for glycerol, polyurethane, and polyester resins
		Agricultural Chemical Manufacturing	Aquatic herbicide, biocide, slimicide
		Military	Component of military poison gases Lacrimogenic warning agent in methyl chloride refrigerant
P005	Allyl alcohol	Agricultural Chemical Manufacturing	Herbicide for weed, seeds and fungi
		Organic Chemical Manufacturing	Intermediate in synthesis of glycerin
		Plastics and Resins Manufacturing	Manufacture of resins and plasticizers
P088	Endothall	Agricultural Chemical Manufacturing	Herbicide, defoliant, dessicant, growth regulator, aquatic algicide and herbicide
P102	Propargyl alcohol	Automotive	Corrosion inhibitor Prevent hydrogen embrittlement of steel
		Organic Chemical Manufacturing	Solvent stabilizer
		Agricultural Chemical Manufacturing	Soil fumigant
		Commercial Testing Laboratories	Lab reagent
		Pharmaceutical Manufacturing	Manufacture of pharmaceuticals

[a] Source: National Library of Medicine, Hazardous Substances Databank (Reference 5).

Table 2-2

NUMBERS OF FACILITIES THAT MAY GENERATE
OXYGENATED HYDROCARBON AND HETEROCYCLIC AND P WASTES

Waste Code	Number of Facilities
U001	6
U002	13
U004	7
U008	4
U031	11
U053	4
U057	18
U085	0
U108	9
U112	5
U113	5
U117	5
U118	2
U122	73
U123	1
U124	6
U125	5
U126	0
U140	8
U147	8
U154	12
U159	31
U161	5
U162	3
U166	4
U182	0
U197	1
U213	6
U248	3
P001	3
P003	2
P005	3
P088	3
P102	1

Sources: 1987 SRI Directory of Chemical Producers, USA (Reference 6).
Hazardous Substances Data Bank (HSDB) (Reference 5).

Table 2-3

NUMBERS OF FACILITIES THAT MAY GENERATE
OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES BY STATE AND EPA REGION

State	EPA Region	Wastes Potentially Generated (No. of Facilities)[a]
Alabama	IV	U122(3)
Arkansas	VI	U122(2)
California	IX	U002(1), U057(2), U122(1), U124(1), U159(2), U161(1)
Connecticut	I	U031(1), U159(1)
Delaware	III	U154(1)
Florida	IV	U057(1), U125(1), U147(1), U154(1), P088(1)
Georgia	IV	U057(1), U122(1), U159(1)
Illinois	V	U004(1), U057(1), U117(1), U122(2), U159(2)
Indiana	V	U002(1), U031(1)
Kansas	VII	U002(1), U004(1), U057(1), U122(2), U159(1)
Kentucky	IV	U057(1), U122(2)
Louisiana	VI	U008(1), U031(2), U057(1), U108(1), U113(1), U122(5), U154(3), U159(1), U162(1), U213(1), P003(1)

[a]Some facilities included here are listed by headquarters location rather than manufacturing site.

Sources: Hazardous Substances Data Bank (HSDB) (Reference 5).
1987 SRI Directory of Chemical Producers, USA (Reference 6).

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Table 2-3 (Continued)

NUMBERS OF FACILITIES THAT MAY GENERATE
OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES BY STATE AND EPA REGION

State	EPA Region	Wastes Potentially Generated (No. of Facilities)[a]
Massachusetts	I	U053(1), U057(1), U108(1), U112(1), U122(1), U159(2)
Michigan	V	U112(1), P088(1)
Minnesota	V	U122(1)
Mississippi	IV	U122(3)
Missouri	VII	U117(1), U122(2)
Montana	VIII	U122(1)
Nebraska	VII	U125(1)
New Jersey	II	U002(1), U004(3), U031(2), U057(1), U108(3), U117(1), U122(5), U124(1), U125(1), U147(1), U159(10), U161(1), U166(1), U213(3), U248(1), P001(1)
New York	II	U057(1), U122(3), U140(1), U147(1), U159(3), U166(1), U248(1), P001(1)
North Carolina	IV	U122(6)
Ohio	V	U001(2), U057(1), U108(1), U122(4), U125(1)
Oregon	X	U122(8)

[a]Some facilities included here are listed by headquarters location rather than manufacturing site.

Sources: Hazardous Substances Data Bank (HSDB) (Reference 5).
1987 SRI Directory of Chemical Producers, USA (Reference 6).

Table 2-3 (Continued)

NUMBERS OF FACILITIES THAT MAY GENERATE
OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES BY STATE AND EPA REGION

State	EPA Region	Wastes Potentially Generated (No. of Facilities)[a]
Pennsylvania	III	U001(1), U002(2), U004(1), U031(2), U053(1), U057(1), U117(1), U122(2), U124(1), U147(2), U159(3)
Puerto Rico	II	U002(1), U004(1), U031(1), U140(1)
South Carolina	IV	U108(1), U122(4)
Tennessee	IV	U053(1), U112(1), U124(1), U140(1), U154(1), U159(1), U161(1), U162(1), U197(1), U213(1)
Texas	VI	U001(3), U002(5), U008(3), U031(2), U057(3), U108(1), U112(2), U113(4), U118(1), U122(10), U123(1), U140(4), U147(1), U154(6), U159(3), U161(1), U162(1), U166(1), U213(1), P005(2)
Virginia	III	U057(1), U117(1), U140(1)
Washington	X	U122(2)
West Virginia	III	U002(2), U053(1), U108(1), U118(1), U122(2), U147(1), U159(1), U161(1)
Wisconsin	V	U057(1), U122(1), U214(2), U125(1), U147(1), U166(1), U248(1), P001(1), P003(1), P005(1), P102(1)

[a]Some facilities included here are listed by headquarters location rather than manufacturing site.

Sources: Hazardous Substances Data Bank (HSDB) (Reference 5).
1987 SRI Directory of Chemical Producers, USA (Reference 6).

0928-06.tlr.3

3.0 IDENTIFICATION OF BEST DEMONSTRATED AVAILABLE TECHNOLOGY (BDAT)

This section presents the Agency's rationale for determining the best demonstrated available technology (BDAT) for oxygenated hydrocarbon and heterocyclic U and P wastes. Proposed BDAT has been determined to be:

- Incineration or fuel substitution for nonwastewater forms of these wastes;
- Incineration for wastewater forms of these wastes that are amenable to quantification in hazardous waste matrices using current analytical methods; and
- Wet air oxidation followed by carbon adsorption, chemical oxidation followed by carbon adsorption, biological treatment followed by carbon adsorption, and incineration for wastewater forms of these wastes that cannot be quantified in hazardous waste matrices using current analytical methods.

Alternate concentration-based treatment standards for all U and P wastewaters have also been developed based on additional wastewater treatment data from several technologies. These data and the corresponding treatment technologies are discussed in Reference 3 and are included in section III.A.2.a.(3.) and III.A.1.h.(b.) of the preamble.

This section presents the Agency's determination of:

- Applicable technologies;
- Demonstrated technologies;
- Available technologies; and
- The best demonstrated available technology for treatment of these wastes.

In determining BDAT, the Agency first determines which technologies are potentially applicable for treatment of the waste(s) of interest. The Agency then determines which of the applicable technologies are demonstrated for treatment of the waste(s) of interest, and of those demonstrated technologies, which are considered to be available for treatment of the waste(s) of interest.

All of the commercial chemical products included in this document are organic. Therefore, the treatment technologies identified in this section are for treatment of hazardous organic constituents. Some of the wastes may contain metals at treatable concentrations as a result of the manner in which the waste was generated; however, the Agency is not identifying applicable, demonstrated, and available technologies for treatment of metals in these U and P wastes at this time because of these wastes are defined as organic chemicals.

3.1 Applicable Treatment Technologies

To be applicable, a technology must theoretically be usable to treat the waste in question or to treat a waste that is similar in terms of parameters that affect treatment selection. (Detailed descriptions of technologies that are applicable to treat listed hazardous wastes are provided in EPA's Treatment Technology Background Document (Reference 7)).

The following subsections present applicable treatment technologies for nonwastewater and wastewater forms of the 34 oxygenated hydrocarbon and heterocyclic U and P wastes.

3.1.1 Nonwastewaters

Since nonwastewater forms of these wastes may contain hazardous organic constituents at treatable concentrations, applicable treatment technologies include those that destroy or reduce the total amount of various organic compounds in the waste. The Agency has identified the following treatment technologies as applicable for these wastes:

- Incineration (fluidized bed, rotary kiln, and liquid injection);
- Fuel substitution;
- Solvent extraction followed by incineration or recycle of the extract;
- Critical fluid extraction followed by incineration of the contaminated solvents; and
- Wet air oxidation.

Total recycle or reuse may also be applicable for certain wastes such as off-specification commercial chemical products. These treatment technologies were identified based on current waste treatment practices and engineering judgment.

Many of the U and P wastes addressed in this document may be generated in a variety of forms, and application of treatment technologies

depends upon the physical form of the waste. For example, a contaminated soil may be amenable to rotary kiln incineration, while an off-specification liquid chemical product may be amenable to liquid injection incineration.

Incineration. Incineration is a destruction technology in which energy, as heat, is transferred to the waste to destabilize chemical bonds and destroy organic constituents. In a fluidized bed incinerator, waste is injected into the fluidized bed material (generally sand and/or incinerator ash), where it is heated to its ignition temperature. Heat energy from the combustion reactions is then transferred back to the fluidized bed. Ash is removed periodically during operation and during bed change-outs.

In a rotary kiln incinerator, wastes are fed into the elevated end of the kiln, and the rotation of the kiln mixes the waste with hot gases to heat the waste to its ignition temperature. Ash is removed from the lower end of the kiln. Combustion gases from the kiln enter the afterburner for complete destruction of organic waste constituents. Other wastes may also be injected into the afterburner.

In a liquid injection incinerator, liquid wastes are atomized and injected into the incinerator. In general, only wastes with low or negligible ash content are amenable to liquid injection incineration. Therefore, this technology generally does not generate an ash residual.

Combustion gases from the incinerator are then fed to a scrubber system for cooling and removal of entrained particulates and acid gases, if present. In general, with the exception of liquid injection incineration, two residuals are generated by incineration processes: ash and scrubber water.

Fuel Substitution. Fuel substitution is a destruction technology in which energy, as heat, is transferred to the water to destabilize chemical bonds and destroy organic constituents. Fuel substitution differs from incineration in that the waste is used as a fuel in industrial furnaces or boilers. Two residuals may be generated by the fuel substitution process: ash and scrubber water.

Solvent Extraction. Solvent extraction is a separation technology in which organics are removed from the waste due to greater constituent solubility in the solvent phase than in the waste phase. This technology results in the generation of two residuals: a treated waste residual and an extract. The extract may be recycled or treated by incineration.

Critical Fluid Extraction. Critical fluid extraction is a solvent extraction technology in which the solvent is brought to its critical state (liquid gas) to aid in the extraction of organic constituents from the wastes. After the extraction step, the solvent is returned to its normal gaseous state, generating a small volume of extract that is concentrated in organic constituents. This technology generates two residuals: a treated waste

residual and an extract. The extract may be recycled or treated by incineration.

Wet Air Oxidation. Wet air oxidation is a destruction technology in which organic constituents in wastes are oxidized and destroyed under high pressure at elevated temperatures in the presence of dissolved oxygen. This technology is applicable for wastes comprised primarily of water and up to 10% total organic constituents. Wet air oxidation generates one treatment residual: treated effluent. The treated effluent may require further treatment for organic constituents by carbon adsorption or PACT^{R} treatment (these technologies are described in Section 3.1.2 of this document). Emissions from wet air oxidation may require further treatment by incineration.

Total Recycle or Reuse. Total recycle or reuse of a waste in the same process or another process eliminates the generation of the waste and generates no treatment residuals.

3.1.2 Wastewaters

Since wastewater forms of these wastes may contain hazardous organic constituents at treatable concentrations, applicable technologies include those that destroy or reduce the total amount of various organic compounds in the waste. Therefore, the Agency has identified the following treatment technologies as potentially applicable for treatment of these wastes:

- Incineration (fluidized bed, rotary kiln, and liquid injection);
- Wet air oxidation;
- PACT^R treatment;
- Biological treatment;
- Carbon adsorption;
- Solvent extraction followed by incineration or recycle of the extract; and
- Chemical oxidation.

Total recycle or reuse may also be applicable for certain wastewaters. These treatment technologies were identified based on current waste treatment practices and engineering judgment.

The concentrations and type(s) of waste constituents present in the waste generally determine which technology is most applicable. Carbon adsorption, for example, is often used as a polishing step following primary treatment by biological treatment, solvent extraction, or wet air oxidation. Typically, carbon adsorption is applicable for treatment of wastewaters, containing less than 0.1% total organic constituents. Wet air oxidation, PACT^R treatment, biological treatment, and solvent extraction are applicable for treatment of wastewaters containing up to 1% total organic constituents. Many of the wastewaters that are the subject of this document may contain constituents that are too toxic to biomass and therefore cannot be treated effectively by biological treatment or PACT^R treatment.

Incineration. Incineration of wastewaters is identical to that of nonwastewaters described previously in Section 3.1.1.

Wet Air Oxidation. Wet air oxidation of wastewaters is identical to that of nonwastewaters described previously in Section 3.1.1.

PACT^R Treatment. PACT^R treatment is a combination of carbon adsorption and biological treatment in which organic constituents are biodegraded or selectively adsorbed onto powdered-activated carbon. This technology generates two treatment residuals: a treated effluent and spent carbon/biosludge. The spent carbon may be regenerated and recycled to the process or may be incinerated.

Biological Treatment. Biological treatment is a destruction technology in which organic constituents in wastewaters are biodegraded. This technology generates two treatment residuals: a treated effluent and a waste biosludge. Waste biosludge may be land disposed without further treatment if it is less than or equal to the BDAT treatment standards.

Carbon Adsorption. Carbon adsorption is a separation technology in which organic constituents in wastewaters are selectively adsorbed onto activated carbon. This technology generates two treatment residuals: a treated effluent and spent activated carbon. The spent activated carbon can be reactivated and recycled.

Solvent Extraction. Solvent extraction of wastewaters is identical to that of nonwastewaters described previously in Section 3.1.1.

Chemical Oxidation. Chemical oxidation is a destruction technology in which inorganic cyanides, some dissolved organic compounds, and sulfides are chemically oxidized to yield carbon dioxide, water, salts, simple organic acids, and, in the case of sulfides, sulfates. This technology generates one treatment residual: treated effluent.

Total Recycle or Reuse. Total recycle or reuse of wastewaters is identical to that of nonwastewaters described previously in Section 3.1.1.

3.2 Demonstrated Treatment Technologies

To be demonstrated, a technology must be employed in full-scale operation for treatment of the waste in question or a similar waste. Technologies available only at pilot- or bench-scale operations are not considered in identifying demonstrated technologies. The following subsections present demonstrated treatment technologies for nonwastewater and wastewater forms of oxygenated hydrocarbon and heterocyclic U and P wastes.

3.2.1 Nonwastewaters

The Agency has identified incineration as a demonstrated technology for treatment of nonwastewater forms of these wastes. For the Land Disposal Restrictions Program, the Agency tested rotary kiln incineration on a full-scale basis for product forms of acetone, ethyl acetate, methyl ethyl ketone, methyl isobutyl ketone, and 1,4-naphthoquinone, as described in Section 4.0 of

this document. (These five products, when wastes, are U002, U112, U159, U161, and U166, respectively.) The Agency believes that since incineration is demonstrated for treatment of these waste constituents, incineration is also demonstrated for all of the oxygenated hydrocarbon and heterocyclic U and P wastes based on similarities in chemical and physical properties, as discussed in Section 2.3.

The Agency has also identified fuel substitution as a demonstrated technology. Although the Agency is not aware of any facilities that treat these oxygenated hydrocarbon and heterocyclic U and P wastes by fuel substitution, the Agency believes that fuel substitution is demonstrated for wastes that are more difficult to treat, such as K027, K111-K116, U221, and U223. K027, K111-K116, U221, and U223 contain dinitrotoluene, toluenediamine, and toluene diisocyanate and other waste constituents that tend to polymerize as discussed in the BDAT Background Document for these wastes (Reference 22). Therefore, the Agency believes these wastes are more difficult to treat than the U and P wastes included in this document.

The Agency is not aware of any facilities that treat nonwastewater forms of these wastes or wastes judged to be similar on a full-scale operational basis using solvent extraction, critical fluid extraction, or wet air oxidation; therefore, EPA believes that these technologies are not currently demonstrated for these wastes.

Although the Agency believes that recycling and reuse is applicable for off-specification U and P wastes, the Agency is not aware of any facilities that do so. Therefore, recycle and reuse is not considered to be demonstrated for these wastes at this time.

3.2.2 Wastewaters

Additional wastewater treatment performance data, primarily from the Agency's Office of Water, have recently been analyzed for the U and P waste constituents included in this document. These data are for treatment of wastewaters that are not specifically listed as U or P wastewaters, but contain many of the corresponding U or P waste constituents. While these data were not available in time to incorporate into this background document, these data are included in the Wastewater Background Document (Reference 3). The following technologies have been identified as demonstrated for treatment of waste constituents in each treatability group:

- Biological Treatment;
- Carbon Adsorption;
- PACT^{R};
- Reverse Osmosis;
- Steam Stripping;
- Wet Air Oxidation;
- Coagulation; and
- Sedimentation.

Based on the technologies listed above, and technologies identified for other similar organic constituents, the Agency considers the following technologies to be demonstrated for treatment of wastewater forms of U and P wastes included in this document: (1) wet air oxidation followed by carbon

adsorption, (2) chemical oxidation followed by carbon adsorption, and (3) biological treatment followed by carbon adsorption.

The Agency is not aware of any facilities that incinerate wastewater forms of the wastes included in this document. However, commenters to the Second Third proposed rule indicated that they were indeed incinerating many wastewaters and that they did not want to be precluded from doing so. Since incineration is demonstrated for treatment of waste constituents in nonwastewater forms of these wastes as discussed in Section 3.2.1, the Agency believes incineration is also demonstrated for these waste constituents in wastewater forms of these wastes. Therefore, the Agency is also identifying incineration as a demonstrated technology for wastewaters.

Although the Agency believes that recycling and reuse is applicable for off-specification U and P wastes, the Agency is not aware of any facilities that do so. Therefore, recycle and reuse is not considered to be demonstrated for these wastes at this time.

3.3 Available Treatment Technologies

An available treatment technology is one that (1) is not a proprietary or patented process that cannot be purchased or licensed from the proprietor (i.e., it must be commercially available), and (2) substantially diminishes the toxicity of the waste or substantially reduces the likelihood of migration of hazardous constituents from the waste.

The demonstrated technologies identified in Section 3.2 are all commercially available. Substantial treatment by incineration for waste constituents of concern and other similar constituents is shown by the treatment performance data included in Section 4.0 of this document. Fuel substitution is considered to provide substantial treatment for the waste constituents of concern. Treatment performance data included in the Wastewater Background Document (Reference 3) show substantial treatment by wet air oxidation, carbon adsorption, biological treatment, and chemical oxidation. Therefore, these technologies are "available" technologies for treatment of the 34 oxygenated hydrocarbon and heterocyclic U and P wastes.

3.4 Identification of BDAT

For a treatment technology to be identified as BDAT, the treatment performance data are first screened to determine:

- Whether the data represent operation of a well-designed and well-operated treatment system;
- Whether sufficient analytical quality assurance/quality control measures were employed to ensure the accuracy of the data; and
- Whether the appropriate measure of performance was used to assess the performance of the particular treatment technology.

All of the incineration data included in Section 4.0 represent BDAT for wastes regulated in this and previous rulemakings and therefore meet the above conditions. Although the Agency does not have treatment performance data from fuel substitution of the waste constituents of concern, the Agency believes that this demonstrated and available technology may also be considered the

best. Therefore, incineration and fuel substitution are the treatment technologies being proposed as BDAT for nonwastewater forms of these wastes.

In cases where the Agency has treatment performance data for wastewater treatment processes and incineration (as measured by total constituent concentrations in scrubber water), the Agency prefers to establish treatment standards based on the wastewater treatment processes. However, since treatment performance data from wastewater treatment processes were not received in time to develop numerical treatment standards for wastewaters that are amenable to quantification in hazardous waste matrices using current analytical methods, incineration is being proposed as BDAT for wastewater forms of these wastes.

Since wet air oxidation followed by carbon adsorption, chemical oxidation followed by carbon adsorption, biological treatment followed by carbon adsorption, and incineration are demonstrated and available for treatment of wastewaters (as discussed in Section 3.2.2 of this document), the Agency is proposing these technologies as BDAT for wastewater forms of these wastes that cannot be quantified in hazardous waste matrices using current analytical methods.

4.0 TREATMENT PERFORMANCE DATA BASE

This section presents the data available to EPA on the performance of treatment technologies that are demonstrated for the 34 oxygenated hydrocarbon and heterocyclic U and P wastes discussed in this document. Table 2-4 summarizes the specific waste codes included in this document and the availability of analytical methods for analysis for each waste constituent. Treatment performance data are not available for those waste constituents that are not amenable to quantification in hazardous waste matrices using current analytical methods. Wastewater treatment performance data from EPA's Office of Water and from EPA-conducted wastewater treatment tests were not available in time for incorporation into this document; these data are included in the Wastewater Background Document (Reference 3) and in the Administrative Record for this rulemaking, as discussed in Section 1.2.

The available treatment performance data are used elsewhere in this document to determine which technologies represent BDAT (Section 3.0), to select constituents for proposed regulation (Section 5.0), and to develop proposed treatment standards (Section 6.0). In addition to using treatment performance data from full-scale operations, eligible data may include those developed at research facilities or obtained at less than full-scale operations, provided that the technology is demonstrated in full-scale operation for a similar waste or wastes (as described in Section 3.0).

U and P wastes can exist in a wide range of physical forms, as discussed in Section 2.2 of this document. In an effort to account for this variability, EPA examined all available BDAT incineration data to develop treatment standards. Specifically, the Agency considered treatment performance data from the 14 EPA-conducted incineration tests listed in Table 4-1. Plant codes cited in Table 4-1 are included in Appendix B. In cases where an individual waste constituent of concern was detected in the untreated or treated wastes from one or more treatment tests, data from only those tests were used to develop treatment standards for that constituent. In cases where an individual waste constituent of concern was not detected in any of the untreated or treated wastes from the 14 treatment tests, detection limits achieved for that constituent in ash and scrubber water residuals from all the tests were used to develop treatment standards, as discussed in Section 6.0 of this document.

In addition, the Agency also considered treatment performance data from the Wastewater Background Document (Reference 3), and is proposing alternative treatment standards based on this data.

Treatment performance data, to the extent that they are available to EPA, include the concentrations for a given constituent in the untreated and treated wastes, values of operating parameters measured at the time the waste was treated, and values of relevant design parameters for the treatment technology. Only treatment performance data for the waste constituents of interest are presented in this section. Values of design and operating

parameters for each treatment test can be found in the corresponding Onsite Engineering Report for each test.

In most cases, multiple sets of treatment performance data were used to develop proposed treatment standards for the waste codes presented in Table 2-4 of this document. The methodology used to develop these treatment standards is discussed in more detail in Section 6.0, and the data that were used to develop proposed treatment standards for these wastes are presented in this section.

For those waste constituents that were detected in the untreated or treated wastes, Table 4-2 presents the concentration at which each constituent was detected in the untreated waste, incinerator ash, and/or scrubber water, and the corresponding test number (assigned in Table 4-1).

The constituents of concern in five of the U and P wastes were detected in either the untreated waste that was incinerated or in the resulting treatment residuals. These U and P wastes are: U002, U112, U159, U161, and U166. The constituents of concern in three of these wastes (U002, U159, and U161) were detected in more than 1 of the 14 tests. Table 4-3 presents the waste constituents that were not detected in any of the 14 tests and the highest detection limits for those waste constituents in ash and scrubber water in each test. Detection limits for methanol (U154) are not available for incinerator ash or scrubber water in any of the 14 incineration tests.

Table 4-1

WASTES TESTED BY INCINERATION

Test Number	Waste Code(s) Tested	Technology Used
1	K001-Pentachlorophenol Waste	Rotary Kiln
2	K001-Creosote Waste	Rotary Kiln
3	K011, K013, K014	Rotary Kiln
4	K019	Rotary Kiln
5	K024	Rotary Kiln
6	K037	Rotary Kiln
7	K048, K051	Fluidized Bed
8	K087	Rotary Kiln
9	K101	Rotary Kiln
10	K102	Rotary Kiln
11	F024	Rotary Kiln
12	K015	Liquid Injection
13	D014, D016, P059*, U127*, U192*	Rotary Kiln
14	U141*, U028*, P020*, U112*, U226*, U239*, U080*, U220*, U166*, U161*, U188*	Rotary Kiln

*Commercial chemical products were used in these test burns as surrogates for these wastes.

Table 4-2

WASTE CONSTITUTENTS THAT WERE DETECTED IN THE OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P UNTREATED OR TREATED WASTES

Waste Code	BDAT #	Waste Constituent	Detected In Treatment Test # [a]	Concentration In Untreated Waste [b] (ppm)	Concentration In Ash (ppm/[# of sample sets]) [b]	Concentration In Scrubber Waster (ppm/[# of sample sets]) [b]
U002	222	Acetone	3	0.081-0.095	<0.05 [7]	<0.05 [6]
			11	<0.05-21,000	<0.01 [6]	<0.01 [6]
			9	<50-81	<0.01 [3]	<0.01 [4]
			13	0.055	<0.01 [3], 0.02 [1]	<0.01 [4]
U112	225	Ethyl acetate	5	<250	<2 [3]	<0.002 [7], 0.036 [1], 0.019 [1], 0.020 [1]
U159	34	Methyl ethyl ketone	6	<500	385 [1], 540 [1], 640 [1], 380 [1], <50 [1], <50 [1]	<0.050 [6]
			12	660-1,000	NA	<0.01 [3]
			4	<1,000-10,000	<10 [6]	<0.01 [6]
			5	200-600	1100 [1], 780 [1], 460 [1]	<0.01 [10]
			8	<2-10	<0.025 [5]	<0.010 [5], 0.014 [1]
			11	2,200	<0.010 [6]	<0.01 [6]
U161	229	Methyl isobutyl ketone	1	0.016	<10 [3]	<0.01 [6]
			14	52,000	<0.020 [4]	<0.01 [4]
U166	122	1,4-Naphthoquinone	14	9,900	<0.36 [1], <0.33 [3]	<0.013 [4]

[a] - Treatment test # is indicated in Table 4-1.
[b] - Number in parenthesis indicates the number of sample sets for which the value was reported.
NA - Not anayized.

TABLE 4-3

SUMMARY OF DETECTION LIMITS FOR OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTE CONSTITUENTS THAT WERE NOT DETECTED IN THE 14 INCINERATION TESTS

Waste Code	BDAT #	Constituent	INCINERATOR ASH DETECTION LIMITS (ppm)													
		TEST NO. [b]:	1	2	3	4	5	6	7	8	9	10	11	12[a]	13	14
P003	2	Acrolein	50	500	0.1	100	NA	500	100	0.5	0.1	30	0.1	NA	0.1	0.1
U031	223	n-Butyl alcohol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.4	0.4
U108	29	1,4-Dioxane	50	NA	NA	NA	100	NA	NA	1	0.2	60	0.2	NA	0.4	0.4
U117	227	Ethyl ether	50	NA	NA	NA	50	NA	NA	NA	NA	NA	NA	NA	0.01	0.01
U118	31	Ethyl methacrylate	2	50	0.01	2	2	10	2	0.5	0.1	30	0.01	NA	0.01	0.01
U140	33	Isobutyl alcohol	0.2	NA	NA	2	NA	NA	2	1	0.2	60	0.2	NA	1	1
U154	228	Methanol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
U162	35	Methyl methacrylate	2	50	0.01	2	2	10	2	0.5	0.1	30	0.1	NA	0.01	0.01
U004	53	Acetophenone	0.5	0.19	0.01	2	0.5	0.4	0.2	2	0.84	2	1.76	NA	0.36	0.36
U197	66	p-Benzoquinone	50	NA	NA	NA	50	40	NA	NA	NA	NA	0.351	NA	NA	NA
U057	232	Cyclohexanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.4	0.4

Waste Code	BDAT #	Constituent	SCRUBBER WATER DETECTION LIMITS (ppm)													
		TEST NO. [b]:	1	2	3	4	5	6	7	8	9	10	11	12	13	14
P003	2	Acrolein	0.002	0.5	0.1	0.1	NA	0.5	0.012	0.1	0.1	0.1	0.1	0.05	0.05	0.05
U031	223	n-Butyl alcohol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2	0.2
U108	29	1,4-Dioxane	0.05	NA	NA	NA	0.1	NA	0.1	0.2	0.2	0.2	0.2	NA	0.2	0.2
U117	227	Ethyl ether	0.05	NA	NA	NA	0.1	NA	NA	NA	NA	NA	NA	0.05	0.005	0.005
U118	31	Ethyl methacrylate	0.002	0.05	0.01	0.002	0.002	0.01	0.0042	0.1	0.1	0.1	0.1	0.002	0.005	0.005
U140	33	Isobutyl alcohol	0.002	0.02	NA	0.002	NA	NA	0.1	0.2	0.2	0.2	0.2	NA	0.5	0.5
U154	228	Methanol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
U162	35	Methyl methacrylate	0.002	0.05	0.01	0.002	0.002	0.01	0.1	0.1	0.1	0.1	0.1	0.002	0.005	0.005
U004	53	Acetophenone	0.01	0.003	0.01	0.002	0.01	0.01	0.01	0.01	0.020	20	0.0605	0.01	0.01	0.013
U197	66	p-Benzoquinone	1	NA	NA	NA	1	1	0.05	0.02	NA	NA	0.0121	1	NA	NA
U057	232	Cyclohexanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2	0.2

NA - Not available
a - Incinerator ash samples were not collected for Test 12.
b - Treatment test number is indicated in Table 4-1.

5.0 SELECTION OF CONSTITUENTS PROPOSED FOR REGULATION

This section presents the methodology and rationale for selection of constituents proposed for regulation in nonwastewater and wastewater forms of the oxygenated hydrocarbon and heterocyclic U and P wastes. Generally, constituents proposed for regulation must satisfy the following criteria:

1. They must be on the BDAT List of constituents. The BDAT List consists of those Appendix VII and VIII constituents for which approved methods exist to analyze for the constituent in treated waste matrices.

2. They must be present in, or be suspected of being present in, the untreated waste. For example, analytical difficulties may prevent a constituent from being identified in the untreated waste, but its identification in a treatment residual may lead the Agency to conclude that it is present in the untreated waste.

Due to the lack of characterization data for the U and P wastes, only the constituent for which a waste was listed was considered in developing numerical treatment standards. However, many of these U and P wastes are not amenable to quantification in hazardous wastes matrices using current analytical methods and, therefore, determining numerical treatment standards for these constituents would not be appropriate. For these U and P wastes, the Agency is instead specifying a method of treatment as the BDAT treatment standard. Table 1-1 summarizes the specific waste codes included in this document and the availability of EPA-approved analytical methods for each waste constituent. Generally, if a U or P waste constituent is on the BDAT List, the Agency prefers to develop numerical treatment standards for that

constituent. Exceptions to this general methodology are discussed in Section 6.0.

For waste constituents included in the oxygenated hydrocarbon and heterocyclic U and P wastes, the Agency is selecting for proposed regulation those waste constituents that are amenable to quantification in hazardous waste matrices using current analytical methods, with two exceptions: methanol and acrolein. Methanol and acrolein are the BDAT list constituents for which U154 and P003 were listed. As discussed in Section 6.1.4, the Agency is specifying a method of treatment as the BDAT treatment standard for nonwastewater and wastewater forms of methanol and for nonwastewater forms of acrolein. Also, for those waste constituents that are not amenable to quantification in hazardous waste matrices using current analytical methods, the Agency is specifying a method of treatment as the BDAT treatment standard, as described in Section 6.0.

The waste constituents that were selected for proposed regulation discussed above are summarized in Table 5-1.

Table 5-1

OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES
FOR WHICH NUMERICAL TREATMENT STANDARDS ARE BEING PROPOSED

Waste Code	Constituent
P003	Acrolein (wastewaters only)
U002	Acetone
U004	Acetophenone
U031	n-Butanol
U057	Cyclohexanone
U108	1,4-Dioxane
U112	Ethyl acetate
U117	Ethyl ether
U118	Ethyl methacrylate
U140	Isobutyl alcohol
U159	Methyl ethyl ketone
U161	Methyl isobutyl ketone
U162	Methyl methacrylate
U166	1,4-Naphthoquinone
U197	p-Benzoquinone

6.0 CALCULATION OF PROPOSED BDAT TREATMENT STANDARDS

The Agency bases numerical treatment standards for regulated constituents on the performance of well-designed and well-operated BDAT treatment systems. These standards account for analytical limitations in available treatment performance data and for variabilities related to treatment, sampling, and analytical techniques and procedures. This section presents proposed treatment standards for the constituents selected for regulation in Section 5.0 using the available performance data from the BDAT treatment technologies.

6.1 Treatment Standards for Waste Constituents With Approved Analytical Methods

Treatment standards for U and P wastes with approved analytical methods were calculated based on data compiled from the BDAT incineration database for incinerator ash and scrubber water residuals. Specifically, the Agency considered treatment performance data from the 14 incineration tests listed in Table 4-1 of this document. Alternate treatment standards for U and P wastewaters were calculated based on wastewater treatment data from EPA's Office of Water and EPA-conducted wastewater treatment tests. These data were not available in time for incorporation into this document; these data are included in the Wastewater Background Document (Reference 3) and in the administrative record for this rulemaking as discussed in Section 1.2.

For each waste code included in this document, the Agency first determined whether the waste constituents of concern were detected in the untreated or treated wastes in any of the 14 treatment tests. Waste constituents that were detected are noted in Table 4-2 and Table 6-1 of this document. Detection limits achieved for the waste constituents in the oxygenated hydrocarbon and heterocyclic U and P wastes that were not quantified above detection limits in any of the 14 treatment tests are presented in Table 4-3 of this document. The highest detection limits achieved for these constituents are summarized in Table 6-1 at the end of this section.

For waste constituents that were detected in the untreated and/or treated waste, proposed treatment standards were developed based on the highest detection limits in ash and scrubber water from those test in which the constituent was detected. For waste constituents that were not detected in any of the untreated or treated wastes in the 14 treatment tests, the Agency developed treatment standards based on the highest detection limits in the ash and scrubber water in all of the 14 treatment tests.

Numerical treatment standards for the waste constituents selected for proposed regulation in Section 5.0 were calculated by multiplying the detection limit for that constituent in the treatment residual by an accuracy correction factor and by a variability factor. The following sections discuss these three components of the treatment standard calculation. These calculations are summarized in Table 6-1 at the end of this section.

6.1.1 Detection Limits

Detection limits (presented in Section 4.0 of this document) for the ash and scrubber water residuals were used to calculate treatment standards for nonwastewater and wastewater forms of these wastes, respectively. In cases where the waste constituent was detected in more than one incineration test, the highest detection limits for the ash and scrubber water were used. For example, methyl isobutyl ketone (U161) was detected in two treatment tests (1 and 14) as indicated in Table 4-2. The highest detection limit for the ash samples was 10 ppm in Test 1. Therefore, 10 ppm was entered into Table 6-1 for methyl isobutyl ketone nonwastewaters. For scrubber water, the detection limit was 0.01 ppm in both tests. This value was entered into Table 6-1 for methyl isobutyl ketone wastewaters.

For each waste constituent that was not detected in the untreated and treated wastes in any of the 14 tests, the highest detection limit reported for the 14 treatment tests was used. For example, ethyl methacrylate (U118) was not detected in any of the 14 treatment tests. Nonwastewater detection limits for this constituent range from 0.01 ppm to 50 ppm as indicated in Table 4-3. Therefore, the detection limit of 50 ppm in Test 2 was entered into Table 6-1 for ethyl methacrylate nonwastewaters. Similarly, a detection limit of 0.1 ppm from Tests 8, 9, 10, and 11 was entered into Table 6-1 for ethyl methacrylate wastewaters.

Exceptions to this general methodology are discussed at the end of this section.

6.1.2 Accuracy Correction Factors

The detection limits used to calculate proposed treatment standards were corrected using matrix spike recovery data from the same test from which the detection limit was taken to account for analytical interferences associated with the chemical matrices of the samples. Detection limits were corrected for accuracy as follows:

(1) A matrix spike recovery was determined for each waste constituent. In cases where a matrix spike was not performed for a waste constituent from the treatment test for which the detection limit was used, the matrix spike recovery from a similar constituent from that treatment test was transferred to that constituent. The source of recovery data used for each constituent is indicated in Table 6-1.

(2) An accuracy correction factor was determined for each of the above constituents by dividing 100 by the matrix spike recovery (percent) for that constituent.

(3) Detection limits for each waste constituent were corrected by multiplying the reported concentration of each constituent by its corresponding accuracy correction factor.

The matrix spike recoveries that were used to adjust detection limits for each of the 14 incineration tests are included in Appendix C. Duplicate matrix spikes were performed for some waste constituents. If a duplicate matrix spike was performed for a constituent, the matrix spike recovery used for that constituent was the lower of the two values from the first matrix spike and the duplicate spike. Matrix spike recoveries of less

than 20% are not acceptable and were not used to correct detection limits. Matrix spike recoveries greater than 100% were considered to be 100% for the purpose of this calculation, so that the data were not adjusted to concentrations below the detection limits. In cases where the detection limit used was from more than one test, matrix spike recovery data from the test resulting with the highest accuracy correction factor was used. The test from which matrix spike recovery data were used is indicated in Table 6-1.

6.1.3 Variability Factors

The variability factor accounts for the variability inherent in treatment system performance, treatment residual collection, and analysis of the treated waste samples. Variability factors could not be calculated for waste constituents that were not detected in the incinerator ash or scrubber water residuals. In these cases, a variability factor of 2.8 was used to account for this inherent variability, as discussed in the Methodology for Developing Treatment Standards (Reference 2). In two cases, constituents were detected in the ash or scrubber water and a variability factor could be calculated. Variability factor calculations are included in Appendix D. The variability factors used to calculate the treatment standards for each waste constituent are included in Table 6-1.

6.1.4 Exceptions to the Treatment Standard Methodology

Exceptions to the methodology used to calculate proposed treatment standards for the oxygenated hydrocarbon and heterocyclic U and P wastes are discussed below.

The preponderance of data for acetophenone indicate that detection limits of less than or equal to 0.06 ppm are routinely achievable in scrubber water matrices. The detection limit achieved for acetophenone in K102 scrubber water in Test 10 was 20 ppm; this value is 333 times greater than the routinely achievable detection limit of 0.06 ppm. Therefore, based on engineering judgement, the Agency considers the detection limit for acetophenone in K102 scrubber water to be an outlier. The next highest detection limit for acetophenone in scrubber water, 0.0605 ppm, was used to calculate the wastewater treatment standard for acetophenone.

Detection limits for acrolein in incinerator ash ranged from 0.01-500 ppm. The Agency determined, based on engineering judgement, that none of the detection limits for this constituent were outliers. This broad range of detection limits suggests that analysis of this constituent is difficult in incinerator ash due to matrix interferences. The treatment standard for P003 nonwastewater based on the highest detection limit for acrolein would be 2,400 ppm. The Agency does not believe that the general methodology is applicable in this case since the magnitude of the numerical

treatment standard does not represent substantial treatment of this constituent by incineration. Therefore, the Agency is instead specifying incineration as the BDAT treatment standard for P003 nonwastewaters.

There were no detection limits available for U154 (methanol) in incinerator ash or scrubber water for any of the 14 incineration tests. The Agency is specifying incineration as a method of treatment as the BDAT treatment standard for U154 nonwastewaters and wet air oxidation followed by carbon adsorption, chemical oxidation followed by carbon adsorption, biological treatment followed by carbon adsorption, and incineration as methods of treatment as the BDAT treatment standard for U154 wastewaters.

6.2 Treatment Standards for Waste Constituents That are Not Amenable to Quantification in Hazardous Waste Matrices Using Current Analytical Methods

The Agency is specifying incineration or fuel substitution as a method of treatment as the proposed BDAT treatment standard for nonwastewater forms of waste constituents that are not amenable to quantification in hazardous waste matrices using current analytical methods. Wet air oxidation followed by carbon adsorption, chemical oxidation followed by carbon adsorption, biological treatment followed by carbon adsorption, and incineration as methods of treatment is the proposed BDAT treatment standard for wastewater forms of waste constituents that are not amenable to quantification in hazardous waste matrices using current analytical methods.

TABLE 6-1

CALCULATION OF NUMERICAL TREATMENT STANDARDS FOR
OXYGENATED HYDROCARBON AND HETEROCYCLIC U AND P WASTES

Waste Code	BDAT #	Constituent	Detection Status in Untreated or Treated Waste (Y or N)	Detection Limit (ppm)	Detection Limit Taken From Test(s) # (a)	Recovery (%)	Source of Recovery Data (BDAT #/Test #)	Accuracy Correction Factor	Variability Factor	Treatment Standard (ppm)
		INCINERATOR ASH								
U002	222	Acetone	Y	0.05	3	99	24/3	1.01	2.8	0.14
U031	223	n-Butyl alcohol	N	0.4	13,14	43	229/14	2.33	2.8	2.6
U108	29	1,4-Dioxane	N	100	5	100	4/5	1.00	2.8	280
U112	225	Ethyl acetate	Y	2	5	100	24/5	1.00	2.8	5.6
U117	227	Ethyl ether	N	50	1,5	100	24/5	1.00	2.8	140
U118	31	Ethyl methacrylate	N	50	2	86	24/2	1.16	2.8	160
U140	33	Isobutyl alcohol	N	60	10	100	24/10	1.00	2.8	170
U159	34	Methyl ethyl ketone	Y	50	6	58	24/6	1.72	2.31	200
U161	229	Methyl isobutyl ketone	Y	10	1	84	47/1	1.19	2.8	33
U162	35	Methyl methacrylate	N	50	2	86	24/2	1.16	2.8	160
U004	53	Acetophenone	N	2	4,8,10	58	102/10	1.72	2.8	9.6
U197	66	p-Benzoquinone	N	50	1,5	80	142/1	1.25	2.8	180
U057	232	Cyclohexanone	N	0.4	13,14	60	142/14	1.67	2.8	1.9
U166	122	1,4-Napthoquinone	Y	0.36	14	54	52/14	1.85	2.8	1.9
		SCRUBBER WATER								
U002	222	Acetone	Y	0.05	3	56	24/3	1.79	2.8	0.25
P003	2	Acrolein	N	0.5	2,6	39	24/6	2.56	2.8	3.6
U031	223	n-Butyl alcohol	N	0.2	13,14	100	229/14	1.00	2.8	0.56
U108	29	1,4-Dioxane	N	0.2	8,9,10,11,13,14	70	4/14	1.43	2.8	0.80
U112	225	Ethyl acetate	Y	0.002	5	100	24/5	1.00	2.58	0.0052
U117	227	Ethyl ether	N	0.1	5	100	24/5	1.00	2.8	0.28
U118	31	Ethyl methacrylate	N	0.1	8,9,10,11	60	24/9	1.67	2.8	0.47
U140	33	Isobutyl alcohol	N	0.5	13,14	100	229/14	1.00	2.8	1.4
U159	34	Methyl ethyl ketone	Y	0.05	6	100	43/6	1.00	2.8	0.14
U161	229	Methyl isobutyl ketone	Y	0.01	1,14	100	229/14	1.00	2.8	0.028
U162	35	Methyl methacrylate	N	0.1	7,8,9,10,11	60	24/9	1.67	2.8	0.47
U004	53	Acetophenone	N	0.0605	11	100	102/11	1.00	2.8	0.17
U197	66	p-Benzoquinone	N	1	1,5,6,12	22	142/1	4.55	2.8	13
U057	232	Cyclohexanone	N	0.2	13,14	40	142/14	2.50	2.8	1.4
U166	122	1,4-Napthoquinone	Y	0.013	14	50	52/14	2.00	2.8	0.073

(a) - Treatment test number is indicated in Table 4-1 of this document.

7.0 ACKNOWLEDGEMENTS

This document was prepared for the U.S. Environmental Protection Agency, Office of Solid Waste, by Radian Corporation under Contract No. 68-W9-0072. This document was prepared under the direction of Mr. James Berlow, Chief, Waste Treatment Branch; Mr. Larry Rosengrant, Acting Section Head, Treatment Technology Section; and Mr. Jerry Vorbach, Project Officer. Mr. Jose Labiosa served as the project manager for oxygenated hydrocarbon and heterocyclic wastes regulatory development. Mr. Steve Silverman served as EPA legal advisor.

The following personnel from Radian Corporation were involved in preparing this document: Mr. John Williams, Program Manager; Ms. Lori Stoll, Project Director; and the Radian engineering team, Ms. Debra Falatko, Ms. Chrisanti Haretos and Ms. Colleen Kane.

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18. U.S. EPA. 1988. U.S. Environmental Protection Agency, Office of Solid Waste. Onsite Engineering Report for John Zink Company for K102. April 25, 1988. Washington, D.C.: U.S. Environmental Protection Agency.

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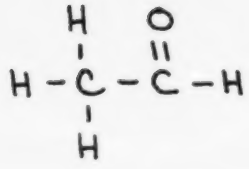
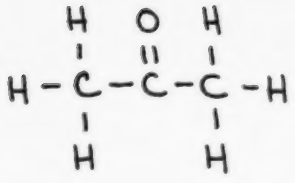
Appendix A

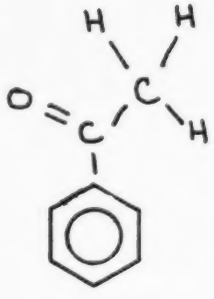
CHEMICAL STRUCTURES OF WASTE CONSTITUENTS INCLUDED IN THIS DOCUMENT



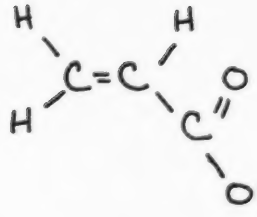
U001 Acetaldehyde



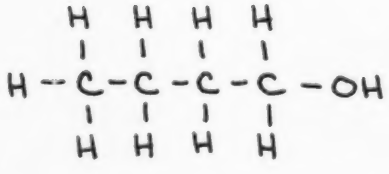
U002 Acetone



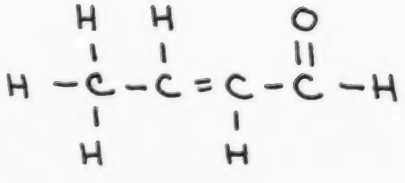
U004 Acetophenone



U008 Acrylic acid

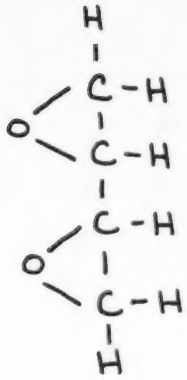


U031 n-Butanol



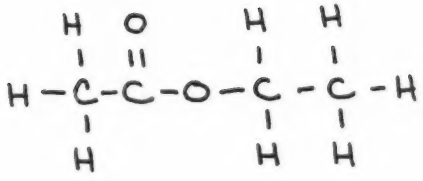
U053 Crotonaldehyde

U057 Cyclohexanone

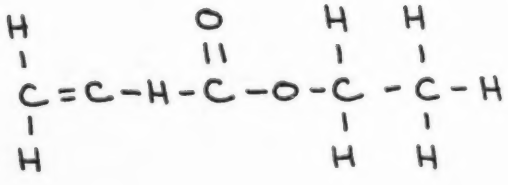


U085 1,2:3,4-Diepoxybutane
(erythritol anhydride)

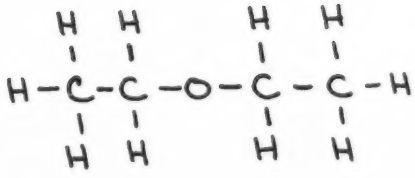
U108 1,4-Dioxane



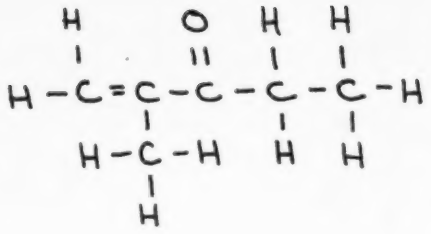
U112 Ethyl acetate



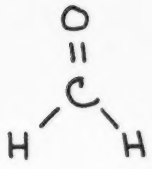
U113 Ethyl acrylate



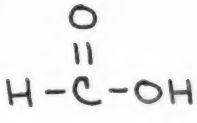
U117 Ethyl ether



U118 Ethyl methacrylate

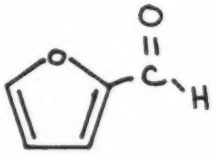


U122 Formaldehyde

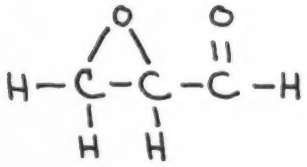


U123 Formic acid

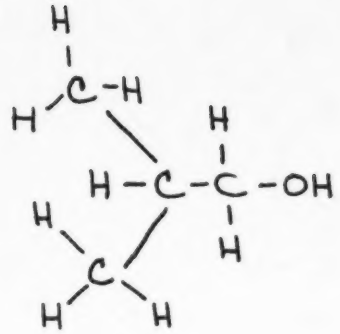
U124 Furan



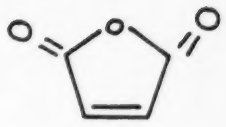
U125 Furfural



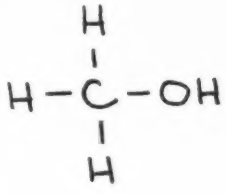
U126 Glycidaldehyde



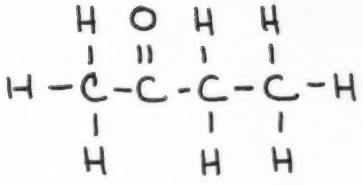
U140 Isobutyl alcohol



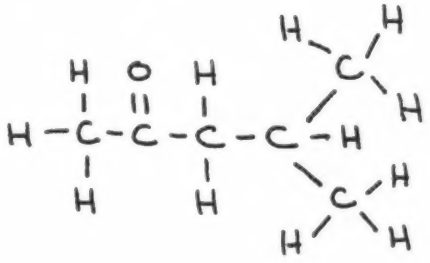
U147 Maleic anhydride



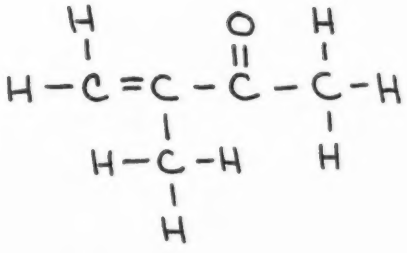
U154 Methanol



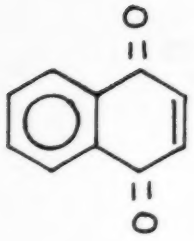
U159 Methyl ethyl ketone



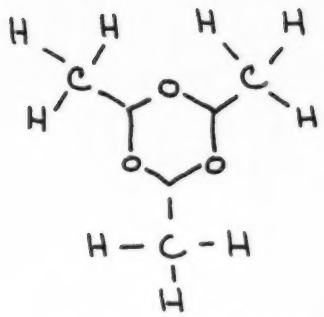
U161 Methyl isobutyl ketone
(Isopropylacetone)



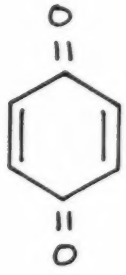
U162 Methyl methacrylate



U166 1,4-Naphthoquinone

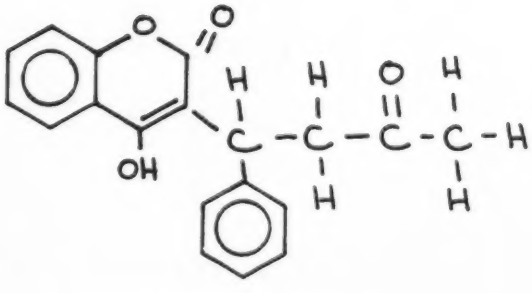


U182 Paraldehyde

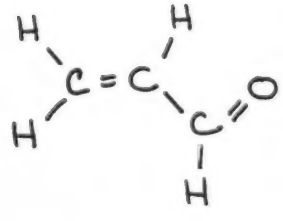


U197 p-Benzoquinone
(quinone)

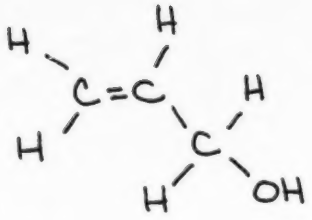
U213 Tetrahydrofuran



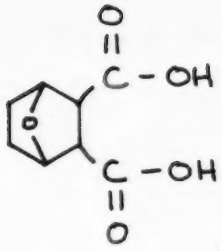
U248 Warfarin
P001



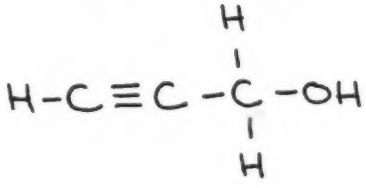
P003 Acrolein



P005 Allyl alcohol



P088 Endothall



P102 Propargyl alcohol

Appendix B

PLANT CODE SUMMARY

Table B-1

PLANT CODES

Plant Code (Test Number)	Facility/Location	Reference Number
1	U.S. EPA Combustion Research Facility, Jefferson, AR	8
2	U.S. EPA Combustion Research Facility, Jefferson, AR	9
3	John Zink Test Facility, Tulsa, OK	10
4	Rollins Environmental Services (TX), Inc., Deer Park, TX	11
5	U.S. EPA Combustion Research Facility, Jefferson, AR	12
6	U.S. EPA Combustion Research Facility, Jefferson, AR	13
7	Amoco Oil Company, Whiting, IN	14,15
8	U.S. EPA Combustion Research Facility, Jefferson, AR	16
9	John Zink Test Facility, Tulsa, OK	17
10	John Zink Test Facility, Tulsa, OK	18
11	ENSCO, El Dorado, AR	19
12	John Zink Test Facility, Tulsa, OK	20
13	John Zink Test Facility, Tulsa, OK	21
14	John Zink Test Facility, Tulsa, OK	21

Appendix C

ACCURACY CORRECTION OF TREATMENT PERFORMANCE DATA

Appendix C

Presented in Table C-1 are the matrix spike recovery data used to correct the detection limits for accuracy, as discussed in Section 6-1. As discussed in Section 6.1, matrix spike recoveries of less than 20% are not acceptable and were not used to correct detection limits. When both the matrix spike and the duplicate matrix spike recoveries exceeded 100%, a value of 100% was used to calculate an accuracy correction factor, so that the data were not adjusted to concentrations below the detection limits.

TABLE C-1

MATRIX SPIKE RECOVERIES USED TO ADJUST DETECTION LIMITS

BOAT #	Constituent	Test 1 Ash	Test 1 Scrubber Water	Test 2 Ash	Test 2 Scrubber Water	Test 3 Ash	Test 3 Scrubber Water	Test 4 Ash	Test 4 Scrubber Water	Test 5 Ash	Test 5 Scrubber Water	Test 6 Ash	Test 6 Scrubber Water	Test 7 Ash	Test 7 Scrubber Water
	Volatile Organics:														
1	Acetonitrile					79,80	86,88								
2	Acrolein					60,47	1.3,0.84								
3	Acrylonitrile					110,108	44,68								
4	Benzene	88,86	82,120	78,88	90,85	141,148	103,109	80,85	84,68	104,104	112,112	104,104,88,94	85,89,85,87	88	111,117
9	Chlorobenzene	124,120	120,104	102,112	90,85	107,107	86,102	99,100	116,92	112,112	120,116	109,109,114,120	121,108,132,129	46	116,116
24	1,1-Dichloroethylene		82,112	88,86	100,97	89,104	71,56	85,78	48,44	140,136	160,164	89,88,58,86	50,39,59,50	96	154,156
229	Methyl isobutyl ketone														
36	Methylene Chloride	109,109	120,120	99,110	103,99	113,117	88,97			122,107	116,116	124,84,166,165	109,116,122,116	80	110,119
43	Toluene														
45	1,1,1-Trichloroethane	86,84	84,84	87,77	89,84	104,105	91,93	107,112	84,109	104,109	84,80	84,84,80,80	79,76,80,80	76	112,116
47	Trichloroethene														112,116
216	1,2-Xylene														109,110
216,217	1,3-Xylene and 1,4-Xylene														
215-217	Total Xylenes														
	Semivolatile Organics:														
51	Acenaphthalene														
52	Acenaphthene	120,120	110,110	0,3.4	61,86										
62	Benzo[a]pyrene							110,110	102,102	86,86	86,86	103,100	140,130	66,63	92,87
70	Bis(2-ethylhexyl)phthalate														99,86
73	2-sec-Butyl-4,6-dinitrophenol			113,88	88,70										84,86
76	p-Chloro-m-cresol	80,85	29,22	35,86	80,73			110,120	87,85	88,86	49,47	88,88	85,85	56,57	133,91
78	2-Chlorophenol	100,105	28,20	59,53	61,66			88,100	81,78	107,109	46,48	75,75	95,90	70,70	115,86
80	Chrysene														106,85
87	p-Dichlorobenzene							80,99	88,70	88,90	88,88	74,74	84,79	75,76	
88	o-Dichlorobenzene	84,84	85,87	48,48	51,61										76,84
98	Di-n-butyl phthalate							107,110	88,84	118,118	114,120	109,112	130,120	54,52	109,47
102	2,4-Dinitrotoluene	120,120	79,84	0,0	21,17			120,130	100,92	40,26	42,44	62,58	86,81	70,70	111,58
105	Di-n-propylnitrosamine	81,82	70,88	87,82	70,58										93,70
109	Fluorene														105,58
110	Hexachlorobenzene														
117	Isosafrole														
121	Naphthalene														
127	4-Nitrophenol	100,80	1.5,0.8	1.2,2.6	0,0										
139	Pentachlorophenol	95,105	3,1.7	0,0	80,85			87,110	82,43	120,114	77,80	100,86	140,120	32,31	116,85
141	Phenanthrene							88,88	58,45	98,91	80,84	48,33	95,90	34,34	78,82
142	Phenol	85,80	30,22	72,85	85,81										51,59
144	Pronamide							80,87	74,70	86,84	38,34	70,87	85,85	85,85	89,71
145	Pyrene	98,100	110,110	0,0	82,80										108,58
150	1,2,4-Trichlorobenzene	95,100	110,120	30,30	72,54			120,92	86,86	94,82	98,100	47,26	110,110	58,53	121,82
	Organochlorine Pesticides:							75,80	80,66	80,90	72,72	85,86	100,94	80,66	83,66
176	gamma-BHC											64,58	84,75		
181	Dieldrin			82,75	80,58							50,39	48,41		
186	Heptachlor														
187	Heptachlor epoxide			75,88	84,80							72,56	75,66		
190	Methoxychlor			118,145	94,82							38,38	110,94		
	Phenoxyacetic Acid Herbicides:														
192	2,4-Dichlorophenoxyacetic acid											55,39	99,84		
193	Silvex			42,89	89,117							64,45	97,89		
194	2,4,5-T											39,27	82,66		

TABLE C-1 (continued)

MATRIX SPIKE RECOVERIES USED TO ADJUST DETECTION LIMITS

SOAT #	Constituent	Test 8 Ash	Test 8 Scrubber Water	Test 9 Ash	Test 9 Scrubber Water	Test 10 Ash	Test 10 Scrubber Water	Test 11 Ash	Test 11 Scrubber Water	Test 12 Ash	Test 12 Scrubber Water	Test 13 Ash	Test 13 Scrubber Water	Test 14 Ash	Test 14 Scrubber Water
	Volatile Organics:														
1	Acetonitrile														
2	Acrolein														
3	Acrylonitrile														
4	Benzene	100,98	106,106	102,106	80,82	104,106	92,90	126,130	86,90		96,96	117,156	96,103	103,87	88,70
8	Chlorobenzene	106,106	112,106	104,110	100,102	106,110	114,110	90,106	110,112		116,112	82,56	121,130	115,109	115,87
24	1,1-Dichloroethylene	114,114	110,106	100,96	80,82	126,130	78,74	80,122	80,80		48,48	35,32	73,76	75,73	89,57
229	Methyl isobutyl ketone											88,117	131,140	48,43	154,121
38	Methylene Chloride											300,309	109,127	120,124	101,91
45	Toluene	108,104	124,124	108,116	90,92	112,114	104,102	170,222	114,114		104,100	243,153	113,122	109,93	108,81
46	1,1,1-Trichloroethane											539,666	122,134	109,110	113,105
47	Trichloroethene	114,114	114,112	116,126	88,102	112,116	114,110	176,216	108,108		92,92	210,294	114,123	109,103	115,88
215	1,2-Xylene														
216,217	1,3-Xylene and 1,4-Xylene														
215-217	Total Xylenes											61,23	82,89	92,91	82,83
	Semivolatile Organics:														
51	Acenaphthalene			41,39	55,58	73,74	82,85								
52	Acenaphthene	93,81	104,84					130,88	78,80		76,80	51,24	53,64	60,54	50,55
62	Benzo(a)pyrene														
70	Bis(2-ethylhexyl)phthalate											66,78	82,89	79,71	105,112
73	2-sec-Butyl-4,6-dinitrophenol											65,13	0,0	41,41	122,123
76	p-Chloro-m-cresol	92,87	107,103	47,44	69,73	88,84	104,109	88,135			90,95	88,84	96,72	90,79	81,93
78	2-Chlorophenol	78,83	108,108	41,39	62,59	62,58	85,92	78,102			75,70	49,42	68,59	53,41	51,74
80	Chrysene														
87	p-Dichlorobenzene														
88	o-Dichlorobenzene	79,88	78,87	40,39	33,33	75,70	48,48	72,90	64,58		40,37	28,23	31,34	28,17	30,36
96	Di-n-butyl phthalate														
102	2,4-Dinitrotoluene	121,108	125,124	48,47	42,53	59,58	92,94	38,100	114,114		25,25	73,56	38,37	71,83	71,77
105	Di-n-propylnitrosamine	92,84	104,98	48,45	59,60	64,61	91,92	110,118	132,116		76,85	58,50	70,87	53,46	58,72
109	Fluorene														
110	Hexachlorobenzene											54,21	48,32	74,139	63,71
117	Isosafrole											34,28	70,77	44,39	48,60
121	Naphthalene														
127	4-Nitrophenol	37,35	117,118	33,32	0,0	22,21	113,127	50,90			100,120	91,48	0,0	77,84	110,98
139	Pentachlorophenol	7,11	107,85	30,25	51,53	38,35	58,62	27,64			70,85	74,0	91,77	77,89	103,11
141	Phenanthrene														
142	Phenol	77,80	98,93	41,40	60,58	85,81	100,107	101,122			60,55	70,61	80,82	70,80	40,72
144	Pronamide											89,89	79,90	92,84	25,12
145	Pyrene	34,39	143,148	46,45	62,63	85,79	98,102	8,82	88,82		52,62	48,0	74,86	73,88	47,48
150	1,2,4-Trichlorobenzene	84,89	77,85	41,39	40,41	75,76	82,54	80,90	82,84		37,35	30,25	35,35	38,24	32,38
	Organochlorine Pesticides:														
178	gamma-BHC														
181	Dieldrin														
186	Heptachlor														
187	Heptachlor epoxide											54,28	67,64	88,93	70,73
190	Methoxychlor														
	Phenoxyacetic Acid Herbicides:											16,0	77,78	0,42	107,102
192	2,4-Dichlorophenoxyacetic acid														
193	Silvex											0,0	22,172	0,0	0,0
	2,4,5-T											0,0	0	0,0	0,0
												0,0	0	0,0	0,0

Appendix D

VARIABILITY FACTOR CALCULATIONS

Appendix D

As discussed in Section 6.1, the variability factor accounts for the variability inherent in treatment system performance, treatment residual collection, and treatment sample analysis. For more information on calculation of variability factors, see EPA's Methodology for Developing BDAT Treatment Standards (Reference 1).

A variability factor was calculated for a constituent when the test from which the detection limit was transferred contained the constituent at concentrations above the detection limit in the treatment residual (ash or scrubber water). This occurred with two constituents proposed for regulation.

The variability factors for U159 nonwastewaters and U112 wastewaters and the data used to calculate them are shown in Table D-1.

Table D-1

VARIABILITY FACTOR CALCULATIONS

U159 NONWASTEWATER

INPUT DATA:

Constituent:	Methyl Ethyl Ketone
BDAT Number:	34
ACF:	1.72

Sample Set	Unadjusted Value (ppm)	A or DL	Adjusted Value (ppm)	ln of Adj Values
1	385	A	662.2	6.495567
2	540	A	928.8	6.833893
3	640	A	1100.8	7.003792
4	380	A	653.6	6.482495
5	250	DL	430	6.603785
6	250	DL	430	6.603785

RESULTS:

Mean of Adj Values =	700.90000
Mean of lns =	6.4906
STD of lns =	0.3862
C99 =	1620.2520
VF =	2.3117

A - Actual Value detected in treated waste.
DL - Detection limit (given when not detected in treated waste).

U112 WASTEWATER

INPUT DATA:

Constituent:	Methyl Ethyl Ketone
BDAT Number:	34
ACF:	1.72

Sample Set	Unadjusted Value (ppm)	A or DL	Adjusted Value (ppm)	ln of Adj. Values
1	0.01	DL	0.01	-4.60517
2	0.01	DL	0.01	-4.60517
3	0.01	DL	0.01	-4.60517
4	0.01	DL	0.01	-4.60517
5	0.01	DL	0.01	-4.60517
6	0.01	DL	0.01	-4.60517
7	0.01	DL	0.01	-4.60517
8	0.036	A	0.036	-3.32423
9	0.019	A	0.019	-3.96331
10	0.02	A	0.02	-3.91202

RESULTS:

Mean of Adj Values =	0.0145
Mean of lns =	-4.3436
STD of lns =	0.4532
C99 =	0.0373
VF =	2.5756